Form FHWA-201 message (Rev. 11-67) Not to

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FEDERAL HIGHWAY ADMINISTRATION

MINUTE-MEMO

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**SUBJECT: Amendment No. 2 – December 2000 Geotechnical Report**
**PROJECT SHIL 502(2) - Foundation Recommendations**

| TO | MESSAGE/COMMENT | FROM/DATE |
|---|---|---|
| K. Nguyen<br>Structural<br>Engineer. | This is the second amendment to the December 2000 geotechnical report to provide drilled shaft foundation recommendations as an alternative to the recommended prestressed concrete piles for several considerations presented in the following paragraphs. The amendment also presents the field and laboratory test results and provides recommendations for the Tilghman Bridge foundations that was added to the project. | K. Mohamed<br>Geotechnical<br>Engineer |
| Through:<br>H. Elgaaly<br>Design Team<br>Leader | ***A) <u>Dill Branch Bridge</u>***<br><br>The first amendment was issued on April 25, 2002 to provide recommendations for the Dill Branch Bridge foundations to support the higher bridge loads that were a result of the new longer bridge alignment. | Through:<br>H. Rohde<br>Division<br>Geotechnical<br>Engineer |
| Through:<br>S. Elnahal<br>Bridge<br>Engineer | The selection of the foundation system, design analysis and recommendations provided in the first amendment were performed assuming that the riprap for the river bank stabilization by the U.S. Army Corp of Engineers (USACE) will be placed to elevations that will provide the slope stability required near pier 1. However, during a field meeting with the park and USACE representatives on June 25 2002, the park indicated that no additional riprap is to be placed within the area around pier 1 for historical and aesthetical considerations. | Through:<br>P. Schneider<br>Technical<br>Services<br>Engineer |
| | Based on the understanding of the Park's intentions and desire and the field conditions around Pier 1, three alternatives were presented to the park as follows:<br><br>1- Design the pier and drilled shafts to withstand a lateral load from a future possible slope failure. The shafts' cap is to remain as close as possible to the existing ground surface to minimize excavations within this area. This alternative is expected to produce an exposed shaft cap following a possible future slope failure and will require high costs for construction of the drilled shafts and a pier to withstand lateral loads from a future possible slope failure.<br><br>2- Excavate the soils around Pier 1 at a 1 : 1 slope beginning from the top of the recently placed riprap at approximate Elevation 116.5 extending to the ditch line on the inner side of the existing roadway. This option includes also lowering the shaft cap by approximately 6.0 (±) meters from its present design elevation. | 08/14/02 |

cc: Bridge (MD, SP), PD (JJ), TS Reading, Geotechnical w/attachments

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3- In addition to the recommendations presented in the second alternative, place a second tier of a rock buttress beginning at the top of the existing riprap to provide long-term stability for the hillside around Pier 1.

Alternatives 1 and 3 are the most and least liked by the Park, respectively. The foundation design analyses were performed based on alternative 2, as this alternative is acceptable by the Park and will provide a more stable and economical foundation and pier design.

A drilled shaft foundation system will provide higher axial and lateral load capacities and minimize the number of shafts (piles) required for carrying the bridge design loads compared to the prestressed concrete piles.

The Design analyses were performed based on the subsurface soil and groundwater conditions encountered in the borings drilled at each substructure location. A detailed description of the subsurface soil and groundwater conditions is presented in the April 2002 memo. The boring locations and the soil profile are shown on the attached drawing. The soils encountered within the site generally consist of sand in loose to medium dense condition to an approximate depth of 6.0 m and dense to very dense condition from an approximate depth of 6.0 m to the termination depth of all borings at 19.0 m.

Drilled shaft design analysis was performed based on the method from "Drilled Shafts: Construction Procedures and Design Method, FHWA Publication No. FHWA-IF-99-025". Scour depths were estimated based on Hydraulic recommendations. A minimum safety factor of 3 was used to calculate the shaft allowable bearing capacity. The Meyerhof drilled shaft allowable bearing capacity method was used for comparison of results. Design analysis results and recommendations for each substructure are presented in Table 1 and include shaft length, shaft approximate top elevation, shaft diameter and allowable bearing capacity.

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## Table 1 – Dill Branch Bridge - Drilled Shaft Recommendations

| Substructure | Shaft Diameter (m) | Approx. Shaft Top Elevation (m) | Shaft Length (m) | Approx. Shaft Tip Elevation (m) | Allowable Bearing Capacity (kN) |
|---|---|---|---|---|---|
| Abutment 1 | 0.61 | 123.0 | 12.25 | 110.75 | 444.0 |
| | 0.61 | 123.0 | 13.75 | 109.25 | 622.0 |
| | 0.61 | 123.0 | 15.25 | 107.75 | 711 |
| Pier 1 | 1.22 | 114.6 | 13.0 | 101.6 | 2224.0 |
| | 1.22 | 114.6 | 14.0 | 100.6 | 2588.0 |
| | 1.22 | 114.6 | 14.5 | 100.1 | 2668.0 |
| Pier 2 | 1.22 | 110.8 | 15.25 | 95.55 | 2224.0 |
| | 1.22 | 110.8 | 16.25 | 94.55 | 2410.0 |
| | 1.22 | 110.8 | 17.75 | 93.05 | 2668.0 |
| Pier3 | 1.22 | 110.3 | 15.25 | 95.05 | 2295.0 |
| | 1.22 | 110.3 | 16.25 | 94.05 | 2464.0 |
| | 1.22 | 110.3 | 17.0 | 93.3 | 2668.0 |
| Abutment 2 | 0.61 | 122.0 | 12.25 | 109.75 | 444.0 |
| | 0.61 | 122.0 | 13.75 | 108.25 | 605.0 |
| | 0.61 | 122.0 | 15.25 | 106.75 | 667.0 |

The drilled shaft approximate top elevations provided in Table 1 were estimated based on information provided by Bridge and the plan and elevation (PE) drawing. If design requires a change in the drilled shaft cap elevation (top elevation), it is recommended to change the cap elevation while maintaining the shaft length as provided in Table 1 or longer and the shaft tip elevation at or below the values recommended in Table 1. It is recommended to provide a minimum center to center drilled shaft spacing of 3 times the shaft diameter.

Per Bridge request, design analysis was also performed for a smaller shaft diameter of 0.91 m for the bridge piers. The smaller shaft diameter was

selected in order to minimize the center-to-center shaft spacing. The results are provided in Table 2.

**Table 2 – Dill Branch Bridge - Drilled Shaft Recommendations**

| Substructure | Shaft Diameter (m) | Approx. Shaft Top Elevation (m) | Shaft Length (m) | Approx. Shaft Tip Elevation (m) | Allowable Bearing Capacity (kN) |
|---|---|---|---|---|---|
| Pier 1 | 0.91 | 114.6 | 20.0 | 94.6 | 2668.0 |
| Pier 2 | 0.91 | 110.8 | 21.35 | 89.5 | 2668.0 |
| Pier3 | 0.91 | 110.3 | 21.35 | 88.9 | 2668.0 |

***B) Tilghman Bridge***

A new 14.35 m long single-span bridge is proposed for the replacement of the Bridge over Tilghman Branch on Cavalry Road. The existing Tilghman Bridge collapsed in July 2001 because of foundations scour problems. The findings of the field investigations, laboratory tests and foundation recommendations are presented in the following paragraphs.

***Field Explorations***

On June 27, 2002; two (2) Borings (B-1 and B-2) were drilled at the proposed locations of the east and west abutments of Tilghman Bridge. Borings were drilled by S&ME, Inc. of Louisville, Tennessee using a truck-mounted CME 550 drill rig. Borings were advanced using hollow-stem augers (HSA) to depths ranging from 15.2 to 16.8 m. Standard penetration resistance tests (SPT) were conducted at 0.76 m intervals to a depth of 4.6 m and at 1.5 m intervals to the termination depth of the Borings.

***Subsurface Conditions***

The subsurface soil and groundwater conditions encountered in the borings are described in the boring logs and expounded as follows:

*Fills* – Fills and/or disturbed soils were encountered to a depth of 2.0 m in both borings. The fills consist predominantly of sand with gravel and trace to some clay. SPT resistances recorded within the fills ranged from 2 to 13 blows per 300 mm indicating very loose to medium dense conditions.

*Sand* – Gray and brown, sand with trace to some clay was encountered from beneath the fill to the termination depths of both borings. SPT resistances recorded within the sand ranged from 4 to over 50 blows per 300 mm indicating very loose to very dense conditions. The loose to medium dense sands were encountered to depths varying from 6.0 to 6.8 m. Medium dense to very dense sand was encountered from depths of 6.0 to 7.0 m to the bottom of the borings.

*Clay* – Brown and gray clay layers with trace to some fine sand were encountered embedded within the sand at various depths in both borings. SPT resistances recorded within the clay ranged from 6 to 38 blows per 300 mm indicating medium stiff to hard clay consistencies.

***Groundwater***

Groundwater was encountered in both borings at depths varying between 2.6 and 2.7 m. Groundwater was measured 24 hours following completion of drilling at depths varying between 1.1 and 1.2 m. Fluctuations in the groundwater level due to seasonal and/or climatic changes should be anticipated.

***Laboratory Investigation***

At the conclusion of the fieldwork, laboratory testing was conducted on select representative soil samples. Laboratory tests included gradation (AASHTO T-27), Atterberg limits (AASHTO T-89, T-90), classification (AASHTO T-317), moisture content (AASHTO T-265), and direct shear test (AASHTO T- 236). The results of the laboratory tests on the jar samples are presented in the attachment.

The laboratory test results indicate that natural moisture contents varied between17.2% and 26.3%, liquid limit indices between non-plastic and 68, plasticity indices between non-plastic and 47, and percent fines between 10.4 and 84.6. Direct shear test on the composite sample from Boring B-1 obtained cohesion (c) of 22 kPa and a friction angle ($\phi$) of 32.8°.

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***Design Analysis***

The Design analyses were performed based on the subsurface soil and groundwater conditions encountered in the borings and the laboratory test results. Spread footings were initially considered for the support of the bridge abutments. However, because of the very loose to loose sands that were encountered in the borings to depths ranging between 6.0 and 7.5 m below the ground surface, spread footings were found not to be a practical option. Construction of spread footings at these depths will require shoring and dewatering which is expected to drive construction costs up. Therefore, an alternative foundation system consisting of drilled shafts was considered for the support of the bridge loads.

Drilled shaft design analysis was performed based on the method from "Drilled Shafts: Construction Procedures and Design Method, FHWA Publication No. FHWA-IF-99-025". Scour depths were estimated based on Hydraulic recommendations. A minimum safety factor of 3 was used to calculate the shaft allowable bearing capacity. The Meyerhof drilled shaft allowable bearing capacity was used to for comparison of results. Design analysis results and recommendations for each substructure are presented in Table 3 and include shaft length, shaft approximate top elevation, shaft diameter and Allowable bearing capacity.

**Table 3 – Tilghman Bridge - Drilled Shaft Recommendations**

| Substructure | Shaft Diameter (m) | Approx. Shaft Top Elevation (m) | Shaft Length (m) | Approx. Shaft Tip Elevation (m) | Allowable Bearing Capacity (kN) |
|---|---|---|---|---|---|
| Abutment 1 | 0.61 | 124.3 | 13.75 | 110.55 | 729.5 |
| | 0.76 | 124.3 | 13.75 | 110.55 | 934.0 |
| Abutment 2 | 0.61 | 124.3 | 13.75 | 110.55 | 729.5 |
| | 0.76 | 124.3 | 13.75 | 110.55 | 934.0 |

The sandy portion of the on-site soils could be used for backfill behind the abutments, wing walls and retaining walls. Use the portion of the on-site material that meet or exceed the AASHTO A-2-4 classification. Recommended soil properties for the fill material behind the retaining walls

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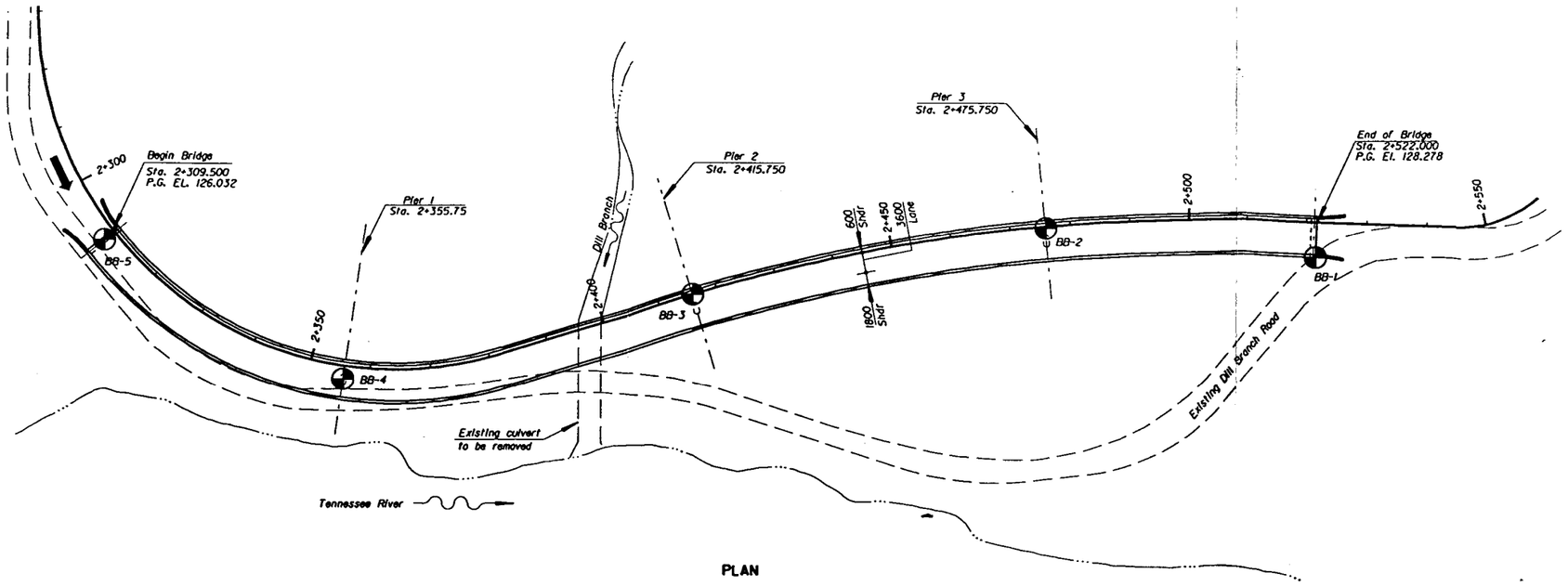
are a minimum unit weight ($\gamma$) of 18.85 kN/m$^3$, a friction angle ($\phi$) of 32° and a friction coefficient of 0.42.

Provide drainage behind the abutment, wing walls and retaining walls consisting of a minimum of 0.5 m of gravel or a geocomposite drain to prevent hydrostatic pressure buildup behind the walls.

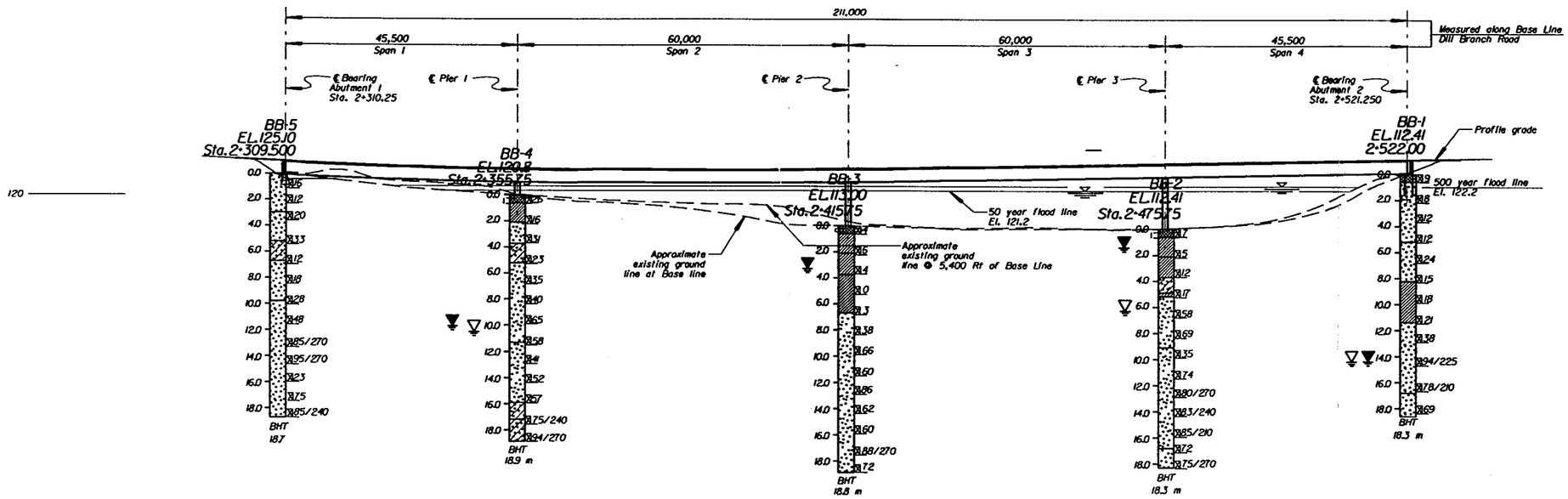
Because of the sandy soil conditions and the shallow depth to ground water at both bridge sites, construction of the drilled shafts is expected to require a construction aid. The construction aid may consist of the use of temporary casings or drilling slurry. The additional costs for the construction aid could be accounted for in the unit cost per foot for the drilled shaft.

Length of Bridge = 212.500 m
Engineers Estimate = $2,800,000

N

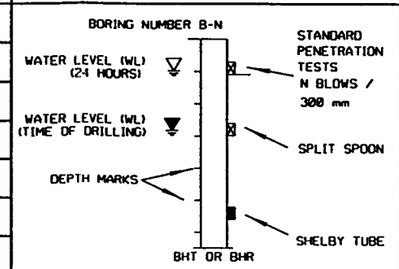



PLAN




| SYMBOL | TYPE OF MATERIAL | SYMBOL | TYPE OF MATERIAL |
|---|---|---|---|
| | FILL | | |
| | CLAY | | |
| | SAND | | |
| | | | |
| | | | |
| | | | |
| | | | |

## TEST BORING




## MISCELLANEOUS

1. SPT-STANDARD PENETRATION TEST -AASHTO T206-74
2. R-REFUSAL, SPT 100 BLOWS/300 mm
3. CR%-PERCENT OF RECOVERY
4. ROD-ROCK QUALITY DESIGNATION
5. BHT-BORE HOLE TERMINATED
6. BHR-BORE HOLE REFUSAL
7. GEOPHYSICAL TEST SITE: SEISMIC (S) RESISTIVITY (R)

SCALE

NTS

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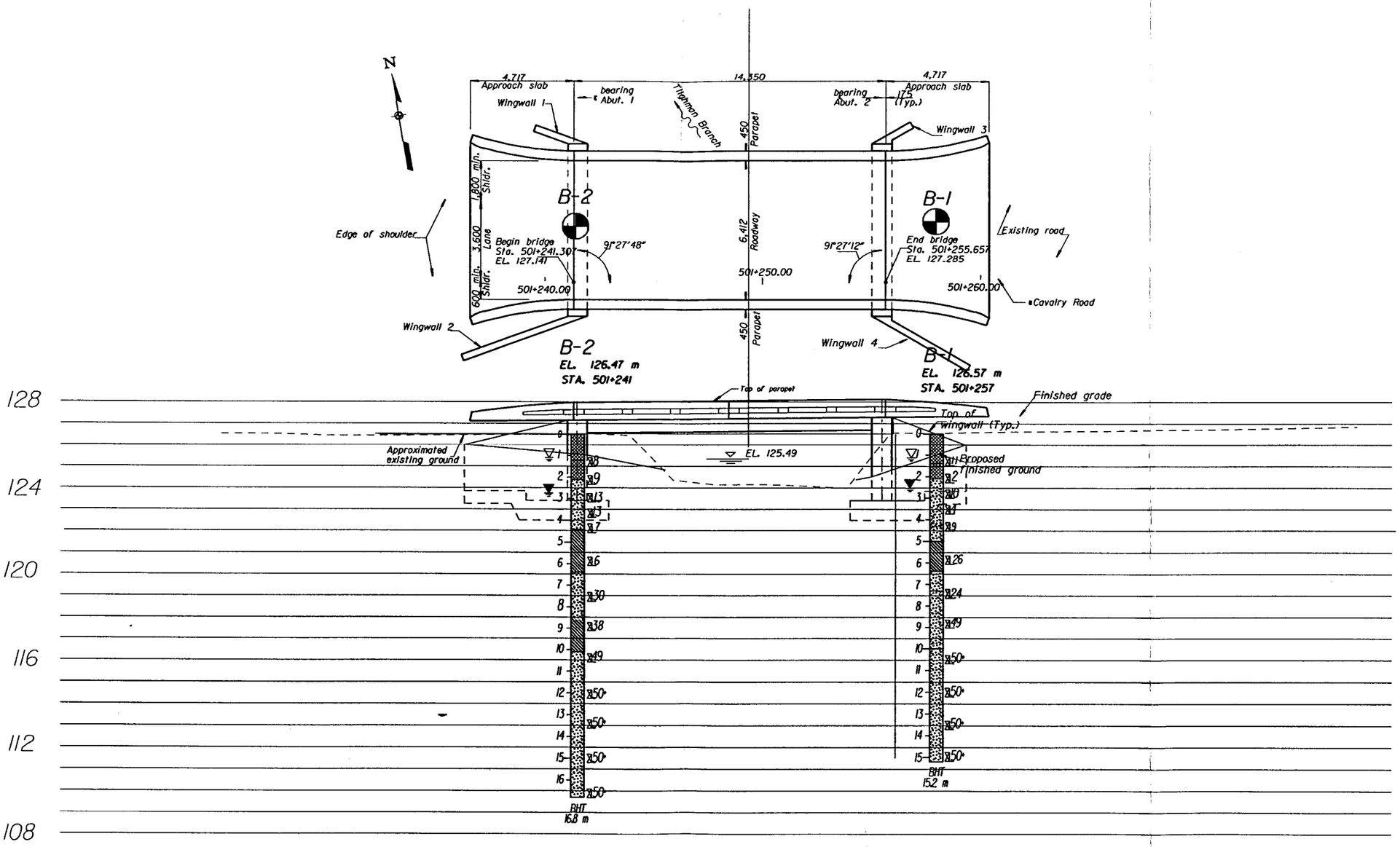
EASTERN FEDERAL LANDS HIGHWAY DIVISION

# BORING LOCATION PLAN AND SUBSURFACE PROFILE

Shiloh National Military Park
Hardin County, TN

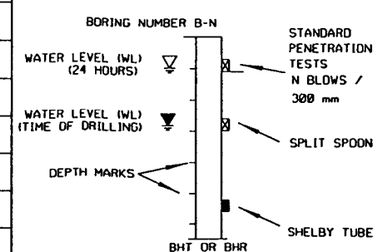
PRA - SHIL 502(2)

Dill Branch Crossing Bridge




| SYMBOL | TYPE OF MATERIAL | SYMBOL | TYPE OF MATERIAL |
|---|---|---|---|
| | FILL | | |
| | SAND | | |
| | CLAY | | |

## TEST BORING




## MISCELLANEOUS

1. SPT-STANDARD PENETRATION TEST -AASHTO T206-74
2. R-REFUSAL, SPT 100 BLOWS/300 mm
3. CR%-PERCENT OF RECOVERY
4. ROD-ROCK QUALITY DESIGNATION
5. BHT-BORE HOLE TERMINATED
6. BHR-BORE HOLE REFUSAL
7. GEOPHYSICAL TEST SITE: SEISMIC (S) RESISTIVITY (R)

SCALE

0 2 5
SCALE IN METERS

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

# BORING LOCATION PLAN AND SUBSURFACE PROFILE

Shiloh National Military Park
Hardidn County, TN

PRA - SHIL 502(2)

Tilghman Bridge

# BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA - SHIL 502(2) | Boring No.: B-1 | Sheet: 1 of 2

Project Location: Shiloh National Military Park, Hardin County, Tennessee | Boring Location: Tilghman Bridge - Abutment 2 (East) @ approx. Station 501+257

Water Depth: | Surface Elevation: 126.57 m | Boring Began: 6/27/02 | Completed: 6/27/02
Encountered at: 2.6 m ▽ | Caved at: | Boring Method: HSA | Inspector: Khalid Mohamed
At Completion: ▼ | Hammer Wt. & Type: 63.5 kg/Auto | Hole Diameter: 203 mm | Operator: David Hedges
After 24 hrs 1.1 m ▼ | Hammer Drop: 76.2 cm | Rock Core Diam: N/A | Weather: Cloudy-Warm

| Elevation (meters) | Graphic Log | Layer Depth (m) | MATERIAL DESCRIPTION (Density, Color, Plasticity, Size, Proportions, Moisture) | Depth Scale (m) | SAMPLE Type | SAMPLE No. | SAMPLE Rec. | SAMPLE Pen. (kg/cm²) | SAMPLE Blows per 150 mm |
|---|---|---|---|---|---|---|---|---|---|
| 126.5 | | 0.0 | Topsoil | | | | | | |
| | | | Medium, brownish tan **SAND** and **GRAVEL**, trace clay (moist) **(FILL)** ▽ | 1 | | | | | |
| 125.2 | | 1.4 | | | | J-1 | | | 8-9-4 |
| | | | Soft, gray **SILTY CLAY**, trace of fine sand, trace of organics (moist) **(FILL)** | 2 | | J-2 | | | 1-1-1 |
| 124.4 | | 2.1 | Medium, brownish tan **SAND**, some silt, some organics (moist to wet) ▽ | 3 | | J-3 | | | 7-7-3 |
| | | | | 4 | | J-4 | | | 6-1-3 |
| | | | | | | J-5 | | | 5-7-2 |
| 121.5 | | 5.0 | | 5 | | | | | |
| | | | Stiff, brownish tan, **CLAY**, trace fine sand (wet) | 6 | | J-6 | | | 6-11-15 |
| 120.2 | | 6.4 | | | | | | | |
| | | | Dense, light tan, fine to medium **SAND**, trace clay (Wet) | 7 | | J-7 | | | 5-10-14 |
| 119.3 | | 7.3 | | | | | | | |
| | | | Very dense, gray, fine **SAND**, some clay (Moist to wet) | 8 | | | | | |
| | | | | 9 | | J-8 | | | 7-20-29 |
| | | | | 10 | | | | | |
| | | | | | | J-9 | | | 7-28-36 |
| | | | | 11 | | | | | |
| | | | | 12 | | J-10 | | | |

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / 0.3m)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1- Boring backfilled with auger cuttings upon completion.

BORING LOG SHIL502(2).GPJ FHWA_VA.GDT 8/14/02

# BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA - SHIL 502(2) Boring No.: B-1 Sheet: 2 of 2

Project Location: Shiloh National Military Park, Hardin County, Tennessee Boring Location: Tilghman Bridge - Abutment 2 (East) @ approx. Station 501+257

Water Depth: Surface Elevation: 126.57 m Boring Began: 6/27/02 Completed: 6/27/02
Encountered at: 2.6 m ▽ Caved at: Boring Method: HSA Inspector: Khalid Mohamed
At Completion: ▼ Hammer Wt. & Type: 63.5 kg/Auto Hole Diameter: 203 mm Operator: David Hedges
After 24 hrs 1.1 m ▼ Hammer Drop: 76.2 cm Rock Core Diam: N/A Weather: Cloudy-Warm

| Elevation (meters) | Graphic Log | Layer Depth (m) | MATERIAL DESCRIPTION<br>Density, Color, Plasticity, Size, Proportions, Moisture | Depth Scale (m) | SAMPLE Type | SAMPLE No. | SAMPLE Rec. | SAMPLE Pen. (kg/cm²) | SAMPLE Blows per 150 mm | ▼ Water Content % / Plastic Limit ⊢—⊣ Liquid Limit / ● Standard Penetration Test Data (Blows / 0.3m) 10 20 40 60 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Very dense, gray, fine **SAND**, some clay (Moist to wet) *(Continued)* | 13 | | | | | 24-36-44 | |
| | | | | 14 | | J-11 | | | 16-26-37 | ● |
| | | | | 15 | | J-12 | | | 12-34-41 | ● |
| 111.3 | | 15.2 | Bottom of Hole @ 15.2 m | 16 | | | | | | |
| | | | | 17 | | | | | | |
| | | | | 18 | | | | | | |
| | | | | 19 | | | | | | |
| | | | | 20 | | | | | | |
| | | | | 21 | | | | | | |
| | | | | 22 | | | | | | |
| | | | | 23 | | | | | | |
| | | | | 24 | | | | | | |

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1- Boring backfilled with auger cuttings upon completion.

BORING LOG SHIL502(2).GPJ FHWA_VA.GDT 8/14/02

# BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA - SHIL 502(2) | Boring No.: B-2 | Sheet: 1 of 2

Project Location: Shiloh National Military Park, Hardin County, Tennessee | Boring Location: Tilghman Bridge - Abutment 1 (West) @ approx. Station 501+241

Water Depth: | Surface Elevation: 126.47 m | Boring Began: 6/27/02 | Completed: 6/27/02
Encountered at: 2.7 m ▽ | Caved at: | Boring Method: HSA | Inspector: Khalid Mohamed
At Completion: ▽ | Hammer Wt. & Type: 63.5 kg/Auto | Hole Diameter: 203 mm | Operator: David Hedges
After 24 hrs 1.2 m ▽ | Hammer Drop: 76.2 cm | Rock Core Diam: N/A | Weather: Partly Cloudy Warm

| Elevation (meters) | Graphic Log | Layer Depth (m) | MATERIAL DESCRIPTION<br>Density, Color, Plasticity, Size, Proportions, Moisture | Depth Scale (m) | SAMPLE Type | No. | Rec. | Pen. (kg/cm²) | Blows per 150 mm | Water Content % / Plastic Limit — Liquid Limit / Standard Penetration Test Data (Blows / 0.3m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 125.2 | | 1.2 | Loose, tan, brown, fine **SAND** and **GRAVEL**, trace clay, trace silt (moist) **(FILL)** | 1 | | | | | | |
| | | | Stiff, tan to light gray, brown sandy **CLAY** (moist) **(FILL)** | | | J-1 | | | 5-4-4 | |
| 124.3 | | 2.1 | | 2 | | J-2 | | | 3-3-6 | |
| | | | Medium dense, tannish brown **SAND** and GRAVEL, trace silt (wet) | 3 | | J-3 | | | 3-5-8 | |
| | | | | | | J-4 | | | 5-6-7 | |
| 122.0 | | 4.4 | | 4 | | J-5 | | | 10-5-2 | |
| | | | Stiff to very stiff, gray, fine sandy **CLAY** (wet) | 5 | | | | | | |
| | | | | 6 | | J-6 | | | 1-2-4 | |
| 120.1 | | 6.4 | | | | | | | | |
| | | | Dense, gray, fine **SAND**, some clay (wet) | 7 | | | | | | |
| | | | | | | J-7 | | | 12-13-17 | |
| 117.8 | | 8.7 | | 8 | | | | | | |
| | | | Hard, gray, fine sandy **CLAY**, trace silt (wet) | 9 | | J-8 | | | 10-10-28 | |
| 116.4 | | 10.1 | | 10 | | | | | | |
| | | | Very dense, gray, fine **SAND**, some clay (wet) | | | J-9 | | | 16-23-26 | |
| | | | | 11 | | | | | | |
| | | | | 12 | | J-10 | | | | |

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1- Boring backfilled with auger cuttings upon completion.

BORING LOG SHIL502(2).GPJ FHWA_VA.GDT 8/14/02

# BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA - SHIL 502(2) Boring No.: B-2 Sheet: 2 of 2

Project Location: Shiloh National Military Park, Hardin County, Tennessee Boring Location: Tilghman Bridge - Abutment 1 (West) @ approx. Station 501+241

Water Depth: Surface Elevation: 126.47 m Boring Began: 6/27/02 Completed: 6/27/02
Encountered at: 2.7 m ▽ Caved at: Boring Method: HSA Inspector: Khalid Mohamed
At Completion: ▼ Hammer Wt. & Type: 63.5 kg/Auto Hole Diameter: 203 mm Operator: David Hedges
After 24 hrs 1.2 m ▼ Hammer Drop: 76.2 cm Rock Core Diam: N/A Weather: Partly Cloudy Warm

| Elevation (meters) | Graphic Log | Layer Depth (m) | MATERIAL DESCRIPTION<br>Density, Color, Plasticity, Size, Proportions, Moisture | Depth Scale (m) | SAMPLE Type | SAMPLE No. | SAMPLE Rec. | SAMPLE Pen. (kg/cm²) | SAMPLE Blows per 150 mm | ▼ Water Content % / Plastic Limit ⊢—⊣ Liquid Limit / ● Standard Penetration Test Data (Blows / 0.3m) 10 20 40 60 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Very dense, gray, fine **SAND**, some clay (wet) *(Continued)* | | | | | | 18-36-48 | |
| | | | | 13 | | | | | | |
| | | | | | | J-11 | | | 15-41-50/4 | 44121" |
| | | | | 14 | | | | | | |
| | | | | 15 | | J-12 | | | 37-50/6 | 637" |
| | | | | 16 | | | | | | |
| 109.7 | | 16.8 | | | | J-13 | | | 22-24-25 | |
| | | | Bottom of Boring @ 16.8 m | 17 | | | | | | |
| | | | | 18 | | | | | | |
| | | | | 19 | | | | | | |
| | | | | 20 | | | | | | |
| | | | | 21 | | | | | | |
| | | | | 22 | | | | | | |
| | | | | 23 | | | | | | |
| | | | | 24 | | | | | | |

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1- Boring backfilled with auger cuttings upon completion.

BORING LOG SHIL502(2).GPJ FHWA_VA.GDT 8/14/02

S&ME

# NATURAL MOISTURE CONTENT

**Job No:** 1432-02-316 **ASTM D:** 2216

**Name:** Shiloh National Military Park

**Operator:** DB **Date:** 7/9/02

| Log Number | Boring Number | Sample Number | Depth (ft) | Natural Moisture Content | Tare Weight | Wet Soil & Tare | Dry Soil & Tare |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1202 | 2 | 7 | 23.5 | 26.3% | 38.30 | 56.06 | 52.36 |
| 1202 | 2 | 8 | 28.5 | 22.7% | 39.09 | 60.84 | 56.81 |
| | | | | | | | |
| 1202 | RB-1 | 1 | 1.0 | 17.6% | 36.24 | 61.55 | 57.77 |
| 1202 | RB-3 | 1 | 1.0 | 24.4% | 36.60 | 63.42 | 58.16 |
| | | | | | | | |
| 1202 | RB-4 | 1 | 1.0 | 19.6% | 37.07 | 95.51 | 85.93 |
| 1202 | RB-6 | 1 | 1.0 | 19.3% | 38.47 | 93.63 | 84.69 |
| 1202 | | | | | | | |
| 1202 | RB-8 | 1 | 1.0 | 17.2% | 37.87 | 62.70 | 59.06 |
| 1202 | RB-9 | 1 | 1.0 | 25.6% | 38.98 | 83.08 | 74.08 |
| | | | | | | | |
| 1202 | 1 | 5 & 6 | | 19.3% | 38.74 | 66.33 | 61.86 |
| | | | | | | | |
| | | | | | | | |

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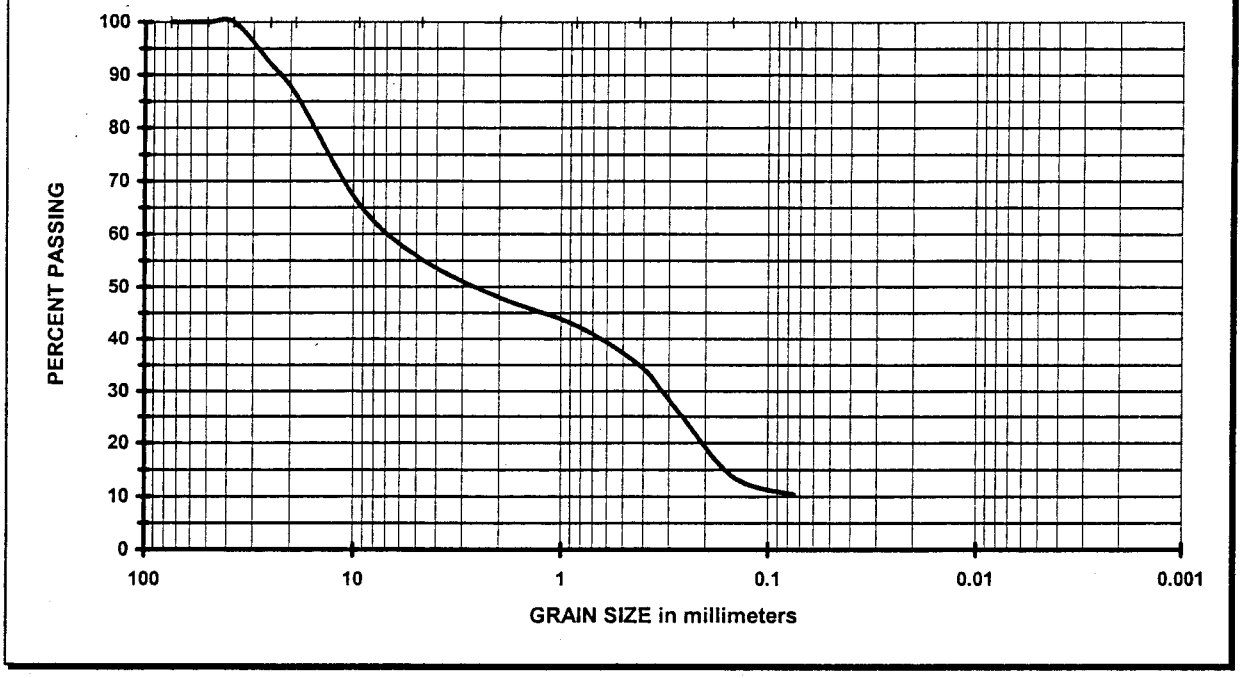
# GRAIN SIZE DATA SHEET

**Job Name:** Shiloh National Military Park
**Job Number:** 1432-02-316

**ASTM:** D 422
**Date:** 7/16/02

## GRAIN SIZE DISTRIBUTION CURVE




| | |
|---|---|
| Gravel | < 75 mm and > 4.75 mm |
| Coarse Sand | < 4.75 mm and >2.00 mm |
| Medium Sand | < 2.00 mm and > 0.425 mm |

| | |
|---|---|
| Fine Sand | < 0.425 mm and > 0.075 mm |
| Silt | < 0.075 and > 0.005 mm |
| Clay | < 0.005 mm |

**Specimen ID :** B-1 S-5 & 6

Soil Description: **Poorly Graded Sand with Silt and Gravel (SP-SM)**

| GRAIN SIZE DATA | |
|---|---|
| % Gravel | 44.8 |
| % Sand | 44.8 |
| % Fines | 10.4 |
| | |
| | |

| ATTERBERG LIMITS DATA | |
|---|---|
| Liquid Limit | NP |
| Plastic Limit | NP |
| Plasticity Index | NP |
| USCS | |
| | |

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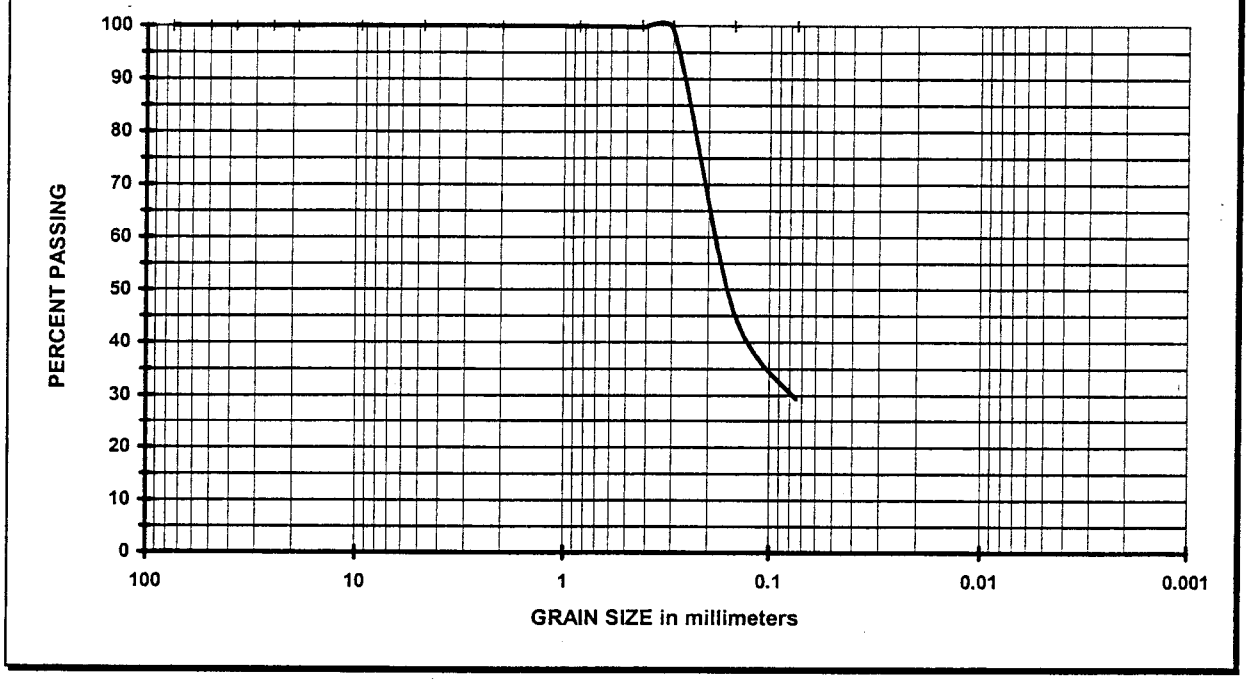
# GRAIN SIZE DATA SHEET

**Job Name:** Shiloh National Military Park
**Job Number:** 1432-02-316

**ASTM:** D 422
**Date:** 7/16/02

## GRAIN SIZE DISTRIBUTION CURVE




| | |
|---|---|
| Gravel | < 75 mm and > 4.75 mm |
| Coarse Sand | < 4.75 mm and >2.00 mm |
| Medium Sand | < 2.00 mm and > 0.425 mm |

| | |
|---|---|
| Fine Sand | < 0.425 mm and > 0.075 mm |
| Silt | < 0.075 and > 0.005 mm |
| Clay | < 0.005 mm |

**Specimen ID :** B 2-7

Soil Description: **Clayey Sand (SC)**

| GRAIN SIZE DATA | |
|---|---|
| % Gravel | 0.0 |
| % Sand | 70.7 |
| % Fines | 29.3 |
| | |
| | |

| ATTERBERG LIMITS DATA | |
|---|---|
| Liquid Limit | 40 |
| Plastic Limit | 15 |
| Plasticity Index | 25 |
| USCS | CL |
| | |

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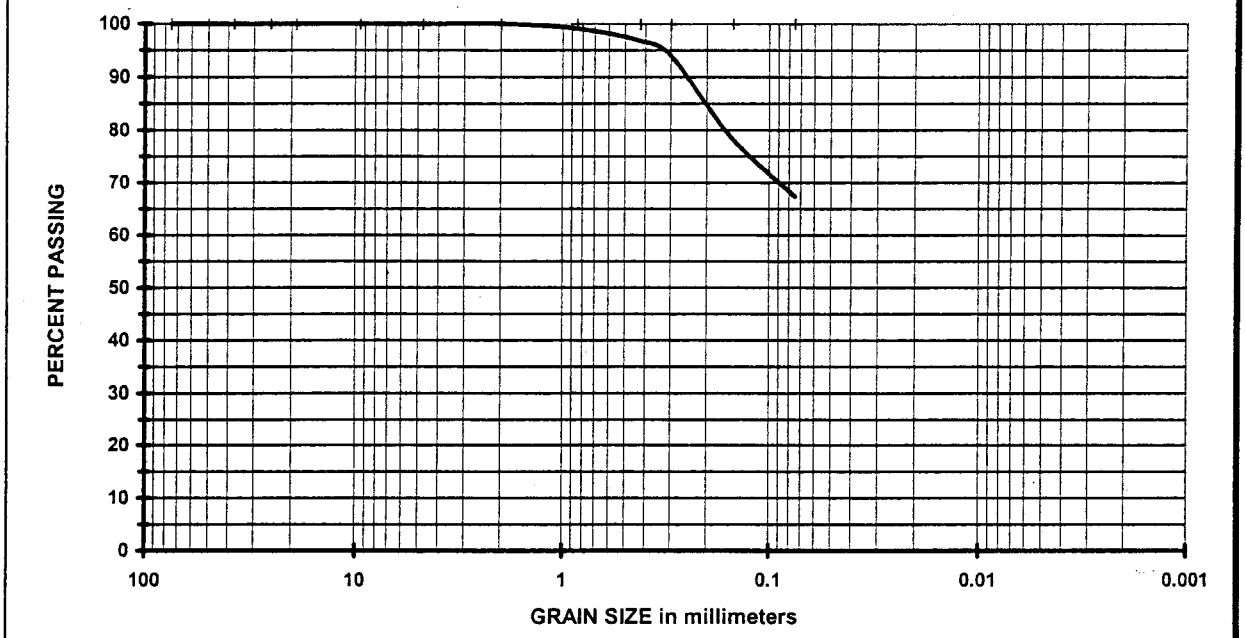
# GRAIN SIZE DATA SHEET

**Job Name:** Shiloh National Military Park
**Job Number:** 1432-02-316

**ASTM:** D 422
**Date:** 7/16/02

## GRAIN SIZE DISTRIBUTION CURVE




| | |
|---|---|
| Gravel | < 75 mm and > 4.75 mm |
| Coarse Sand | < 4.75 mm and >2.00 mm |
| Medium Sand | < 2.00 mm and > 0.425 mm |

| | |
|---|---|
| Fine Sand | < 0.425 mm and > 0.075 mm |
| Silt | < 0.075 and > 0.005 mm |
| Clay | < 0.005 mm |

**Specimen ID :** B 2-8 28.5 Ft.

Soil Description: **Sandy Fat Clay (CH)**

| GRAIN SIZE DATA | |
|---|---|
| % Gravel | 0.0 |
| % Sand | 32.7 |
| % Fines | 67.3 |
| | |
| | |

| ATTERBERG LIMITS DATA | |
|---|---|
| Liquid Limit | 68 |
| Plastic Limit | 21 |
| Plasticity Index | 47 |
| USCS | CH |
| | |

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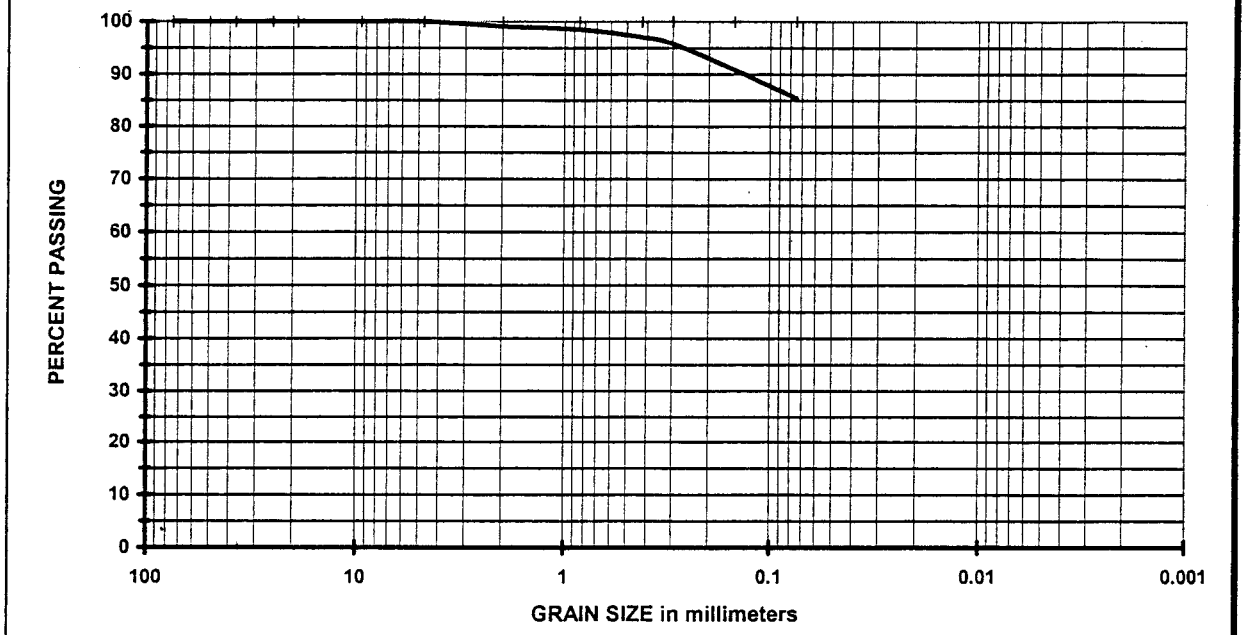
# GRAIN SIZE DATA SHEET

**Job Name:** Shiloh National Military Park
**Job Number:** 1432-02-316

**ASTM:** D 422
**Date:** 7/16/02

## GRAIN SIZE DISTRIBUTION CURVE




| | |
|---|---|
| Gravel | < 75 mm and > 4.75 mm |
| Coarse Sand | < 4.75 mm and >2.00 mm |
| Medium Sand | < 2.00 mm and > 0.425 mm |

| | |
|---|---|
| Fine Sand | < 0.425 mm and > 0.075 mm |
| Silt | < 0.075 and > 0.005 mm |
| Clay | < 0.005 mm |

**Specimen ID :** RB 1.1 1.0 Ft.

Soil Description: **Lean Clay (CL)**

| GRAIN SIZE DATA | |
|---|---|
| % Gravel | 0.0 |
| % Sand | 14.6 |
| % Fines | 85.4 |
| | |
| | |

| ATTERBERG LIMITS DATA | |
|---|---|
| Liquid Limit | 37 |
| Plastic Limit | 20 |
| Plasticity Index | 17 |
| USCS | CL |
| | |

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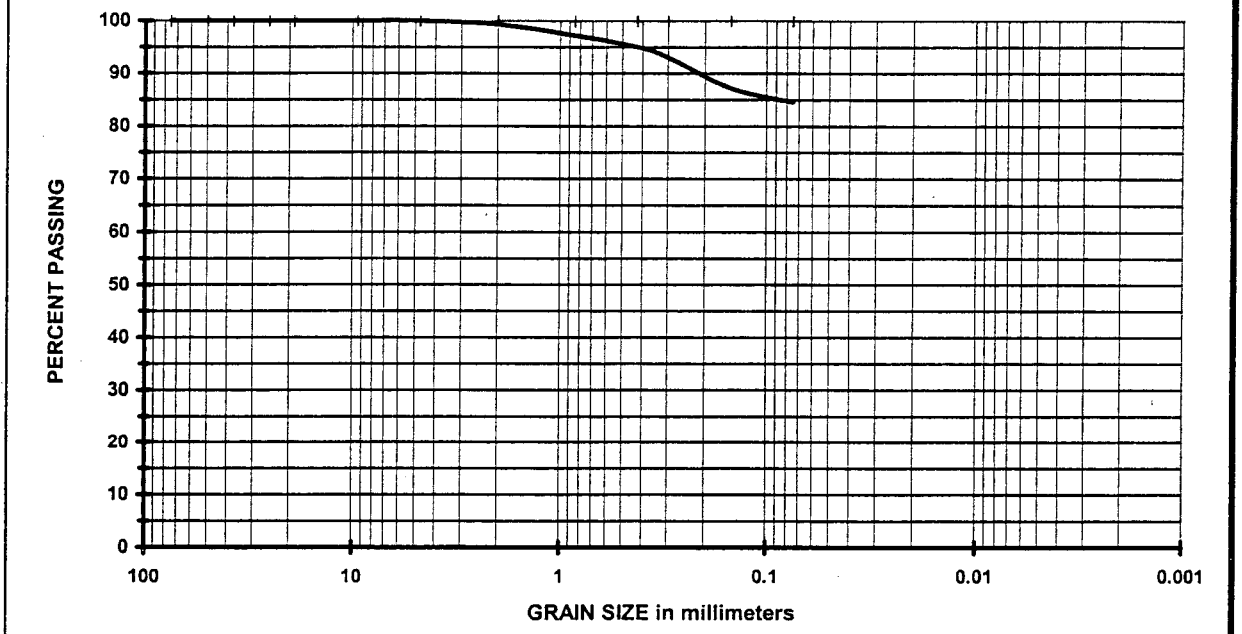
# GRAIN SIZE DATA SHEET

**Job Name:** Shiloh National Military Park
**Job Number:** 1432-02-316

**ASTM:** D 422
**Date:** 7/16/02

## GRAIN SIZE DISTRIBUTION CURVE




| | |
|---|---|
| Gravel | < 75 mm and > 4.75 mm |
| Coarse Sand | < 4.75 mm and >2.00 mm |
| Medium Sand | < 2.00 mm and > 0.425 mm |

| | |
|---|---|
| Fine Sand | < 0.425 mm and > 0.075 mm |
| Silt | < 0.075 and > 0.005 mm |
| Clay | < 0.005 mm |

**Specimen ID :** RB-3 1.0 Ft.

Soil Description: **Lean Clay with Sand (CL)**

| GRAIN SIZE DATA | |
|---|---|
| % Gravel | 0.0 |
| % Sand | 15.4 |
| % Fines | 84.6 |
| | |
| | |

| ATTERBERG LIMITS DATA | |
|---|---|
| Liquid Limit | 41 |
| Plastic Limit | 22 |
| Plasticity Index | 19 |
| USCS | CL |
| | |

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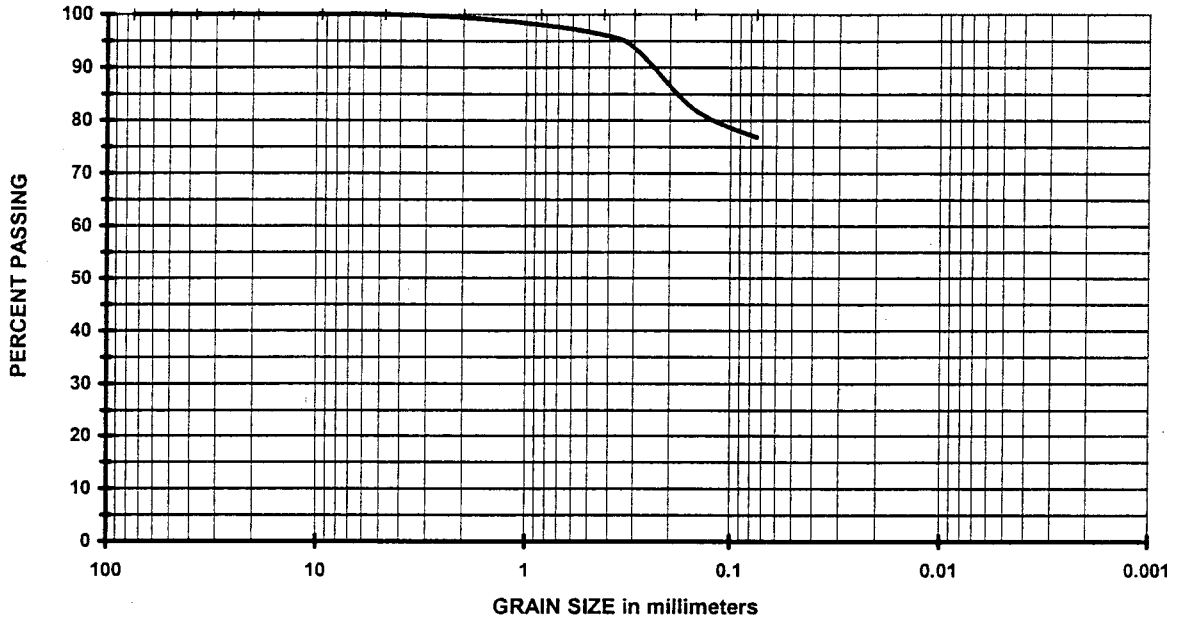
# GRAIN SIZE DATA SHEET

**Job Name:** Shiloh National Military Park
**Job Number:** 1432-02-316

**ASTM:** D 422
**Date:** 7/16/02

## GRAIN SIZE DISTRIBUTION CURVE




| | |
|---|---|
| Gravel | < 75 mm and > 4.75 mm |
| Coarse Sand | < 4.75 mm and >2.00 mm |
| Medium Sand | < 2.00 mm and > 0.425 mm |

| | |
|---|---|
| Fine Sand | < 0.425 mm and > 0.075 mm |
| Silt | < 0.075 and > 0.005 mm |
| Clay | < 0.005 mm |

**Specimen ID :** RB-8 1.0 Ft.

Soil Description: **Lean Clay with Sand (CL)**

| GRAIN SIZE DATA | |
|---|---|
| % Gravel | 0.0 |
| % Sand | 23.3 |
| % Fines | 76.7 |
| | |
| | |

| ATTERBERG LIMITS DATA | |
|---|---|
| Liquid Limit | 37 |
| Plastic Limit | 20 |
| Plasticity Index | 17 |
| USCS | CL |
| | |

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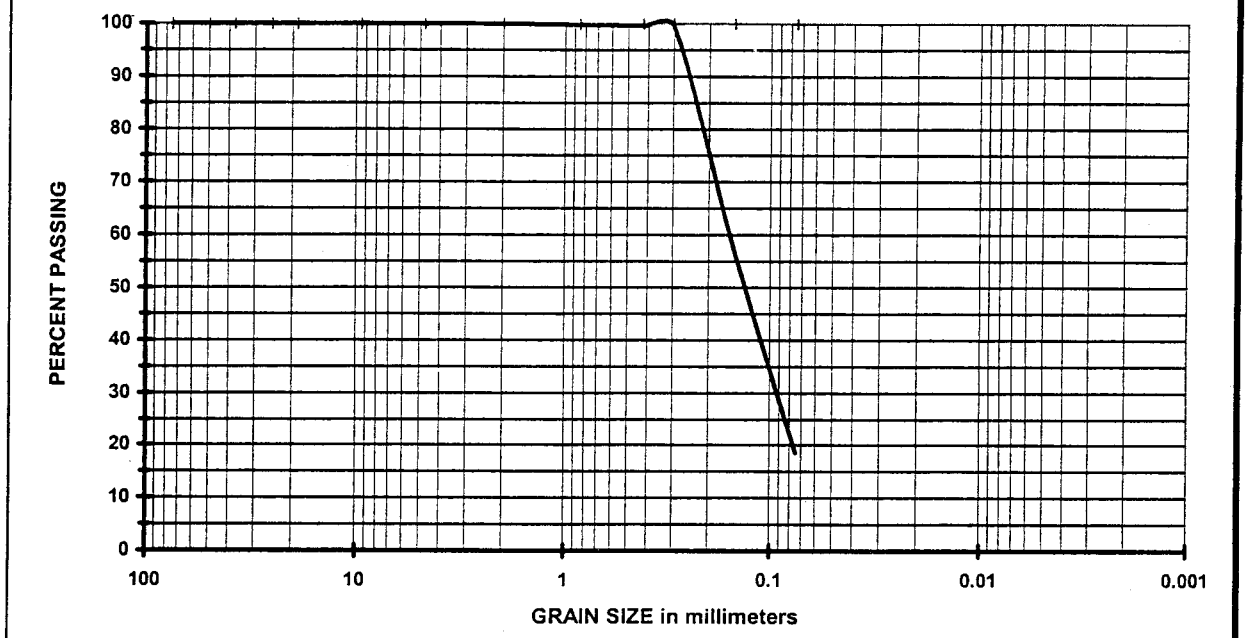
# GRAIN SIZE DATA SHEET

**Job Name:** Shiloh National Military Park
**Job Number:** 1432-02-316

**ASTM:** D 422
**Date:** 7/16/02

## GRAIN SIZE DISTRIBUTION CURVE




| | |
|---|---|
| Gravel | < 75 mm and > 4.75 mm |
| Coarse Sand | < 4.75 mm and >2.00 mm |
| Medium Sand | < 2.00 mm and > 0.425 mm |

| | |
|---|---|
| Fine Sand | < 0.425 mm and > 0.075 mm |
| Silt | < 0.075 and > 0.005 mm |
| Clay | < 0.005 mm |

**Specimen ID :** B-1 S-7, 11, 12

Soil Description: **Clayey Sand (SC)**

| GRAIN SIZE DATA | |
|---|---|
| % Gravel | 0.0 |
| % Sand | 81.5 |
| % Fines | 18.5 |
| | |
| | |

| ATTERBERG LIMITS DATA | |
|---|---|
| Liquid Limit | 27 |
| Plastic Limit | 18 |
| Plasticity Index | 9 |
| USCS | CL |
| | |

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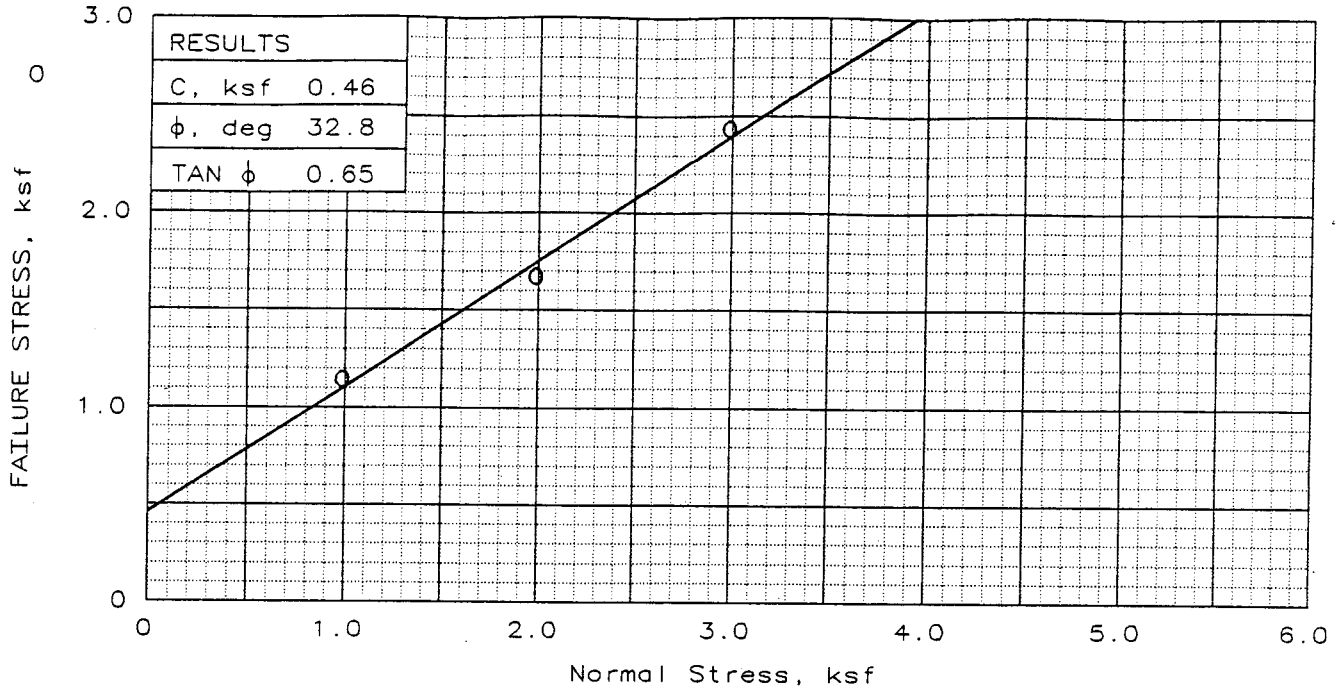


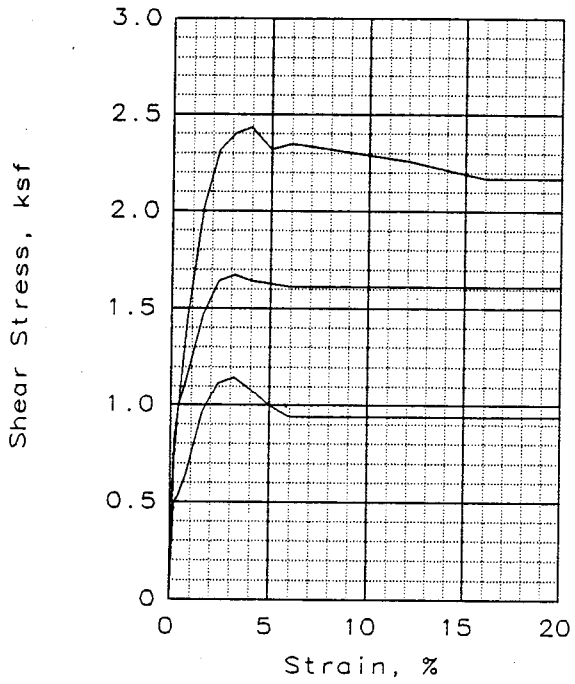


| SAMPLE NO.: | | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 17.6 | 17.6 | 17.6 |
| | DRY DENSITY, pcf | 101.9 | 104.6 | 103.3 |
| | SATURATION, % | 75.0 | 80.4 | 77.7 |
| | VOID RATIO | 0.624 | 0.582 | 0.602 |
| | DIAMETER, in | 2.50 | 2.50 | 2.50 |
| | HEIGHT, in | 1.43 | 1.40 | 1.29 |
| AT TEST | WATER CONTENT, % | 22.0 | 17.6 | 17.6 |
| | DRY DENSITY, pcf | 103.7 | 107.0 | 106.4 |
| | SATURATION, % | 97.7 | 85.6 | 84.4 |
| | VOID RATIO | 0.595 | 0.546 | 0.554 |
| | DIAMETER, in | 2.50 | 2.50 | 2.50 |
| | HEIGHT, in | 1.41 | 1.37 | 1.25 |
| NORMAL STRESS, ksf | | 1.00 | 2.00 | 3.00 |
| FAILURE STRESS, ksf | | 1.14 | 1.67 | 2.43 |
| STRAIN, % | | 3.2 | 3.2 | 4.0 |
| ULTIMATE STRESS, ksf | | | | |
| STRAIN, % | | | | |
| Strain rate, in/min | | 0.0200 | 0.0200 | 0.0200 |

SAMPLE TYPE: Remolded
DESCRIPTION: Greenish Clayey Sand

ASSUMED SPECIFIC GRAVITY= 2.65
REMARKS:

Page No.: _____

CLIENT:

PROJECT: Shiloh National Military Park

SAMPLE LOCATION: B-1 / SS-7,8,9,10,11

PROJ. NO.: 1432-02-316 DATE: 7-12-02

DIRECT SHEAR TEST REPORT

**S & ME, INC.**

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutment 1 - Wingwalls**
Load ($Q_{applied}$) = **65.0** Tons
Top of Caisson Elevation = **405** ft
Bottom of Caisson Elevatio **365** ft
Diameter of Caisson (D) = **2.0** ft
Original Ground Surface = **410.4** ft
Closest Boring: **BB-5**
Depth to Water Table = **20.0** ft
Caisson Length = **40.0** ft

Project Name **Dill Branch Bridge - Latest Bridge Alignment**
Project No.: **PRA - SHIL 502(2)**
Date: **8/6/2002**

Moist Unit Weight of soil: **115** pcf
Saturated Unit Weight of soil: **120** pcf
Bouyant Unit Weight of soil: 57.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **410.4** | **405** | 5.4 | 2.7 | **0** | 2E-05 | 0.16 | 0 | 1 | 0.830 | 0.002 | | 0 | 0 | | |
| 2 | **405** | **393** | 12 | 11.4 | **14** | 2.8 | 0.66 | 4 | 30 | 1.032 | 0.393 | | 0 | 30 | | |
| 3 | **393** | **378** | 15 | 24.9 | **15** | 3 | 1.29 | 2 | 30 | 0.759 | 0.572 | | 0 | 54 | | |
| 4 | **378** | **370.4** | 7.6 | 370.4 | **35** | 7 | 11.24 | 1 | 31 | 0.378 | 2.567 | | 0 | 123 | | |
| 5 | **370.4** | **365** | 5.4 | 42.7 | **50** | 10 | 1.80 | 6 | 31 | 1.170 | 1.284 | | | 44 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **365** | | 45.4 | **50** | 10 | 1.88 | 5 | 31.33 | | | 1 | 15 | | 48 | |
| | | | | | | | | | | | | | Totals: | 250 | 48 | 298 |

FS = 4.6

**Meyerhof:**

$N_{ave}$: 23
$N_{corr}$: 40
$f_s$: 0.228 tsf
Enter (1) for Sand or (2) for $q_p$: **1**
53 tsf

$Q_s$: 30 Tons
$Q_p$: 166 Tons
$Q_{ult}$: 196 Tons

FS = 3.0

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutment 1 - Wingwalls**

Load ($Q_{applied}$) = **70.0** Tons

Top of Caisson Elevation = **405** ft

Bottom of Caisson Elevatio **360** ft

Diameter of Caisson (D) = **2.0** ft

Original Ground Surface = **410.4** ft

Closest Boring: **BB-5**

Depth to Water Table = **20.0** ft

Caisson Length = **45.0** ft

Project Name **Dill Branch Bridge - Latest Bridge Alignment**

Project No.: **PRA - SHIL 502(2)**

Date: **8/6/2002**

Moist Unit Weight of soil: **115** pcf

Saturated Unit Weight of soil: **120** pcf

Bouyant Unit Weight of soil: 57.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **410.4** | **405** | 5.4 | 2.7 | **0** | 2E-05 | 0.16 | 0 | 1 | 0.830 | 0.002 | | 0 | 0 | | |
| 2 | **405** | **393** | 12 | 11.4 | **14** | 2.8 | 0.66 | 4 | 30 | 1.032 | 0.393 | | 0 | 30 | | |
| 3 | **393** | **378** | 15 | 24.9 | **15** | 3 | 1.29 | 2 | 30 | 0.759 | 0.572 | | 0 | 54 | | |
| 4 | **378** | **370.4** | 7.6 | 370.4 | **35** | 7 | 11.24 | 1 | 31 | 0.378 | 2.567 | | 0 | 123 | | |
| 5 | **370.4** | **360** | 10.4 | 45.2 | **50** | 10 | 1.88 | 5 | 31 | 1.146 | 1.309 | | | 86 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **355** | | 55.4 | **50** | 10 | 2.17 | 5 | 31.33 | | | 1 | 16 | | 50 | |
| | | | | | | | | | | | | | Totals: | 292 | 50 | 341 |

FS = 4.9

**Meyerhof:**

$N_{ave}$: 23

$N_{corr}$: 37

$f_s$: 0.228 tsf

Enter (1) for Sand or (2) for $q_p$: **1**

50 tsf

$Q_s$: 30 Tons

$Q_p$: 156 Tons

$Q_{ult}$: 186 Tons

FS = 2.7

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutment 1 - Wingwalls**

Load ($Q_{applied}$) = **80.0** Tons

Top of Caisson Elevation = **405** ft

Bottom of Caisson Elevatio **355** ft

Diameter of Caisson (D) = **2.0** ft

Original Ground Surface = **410.4** ft

Closest Boring: **BB-5**

Depth to Water Table = **20.0** ft

Caisson Length = **50.0** ft

Project Name **Dill Branch Bridge - Latest Bridge Alignment**

Project No.: **PRA - SHIL 502(2)**

Date: **8/6/2002**

Moist Unit Weight of soil: **115** pcf

Saturated Unit Weight of soil: **120** pcf

Bouyant Unit Weight of soil: 57.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **410.4** | **405** | 5.4 | 2.7 | **0** | 2E-05 | 0.16 | 0 | 1 | 0.830 | 0.002 | | 0 | 0 | | |
| 2 | **405** | **393** | 12 | 11.4 | **14** | 2.8 | 0.66 | 4 | 30 | 1.032 | 0.393 | | 0 | 30 | | |
| 3 | **393** | **378** | 15 | 24.9 | **15** | 3 | 1.29 | 2 | 30 | 0.759 | 0.572 | | 0 | 54 | | |
| 4 | **378** | **370.4** | 7.6 | 370.4 | **35** | 7 | 11.24 | 1 | 31 | 0.378 | 2.567 | | 0 | 123 | | |
| 5 | **370.4** | **355** | 15.4 | 47.7 | **50** | 10 | 1.95 | 5 | 31 | 1.124 | 1.333 | | | 129 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **355** | | 55.4 | **50** | 10 | 2.17 | 5 | 31.33 | | | 1 | 16 | | 50 | |
| | | | | | | | | | | | | | Totals: | 335 | 50 | 385 |

FS = **4.8**

**Meyerhof:**

$N_{ave}$: 23

$N_{corr}$: 37

$f_s$: 0.228 tsf

Enter (1) for Sand or (2) for: **1**

$q_p$: 50 tsf

$Q_s$: 30 Tons

$Q_p$: 156 Tons

$Q_{ult}$: 186 Tons

FS = 2.3

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 1** | Project Name | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$) = | **250.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation = | **376** ft | Date: | **8/2/2002** |
| Bottom of Caisson Elevatio | **334** ft | | |
| Diameter of Caisson (D) = | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface = | **386** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-4** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **7.0** ft | | |
| Caisson Length = | **42.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **376** | **366** | 10 | 15 | **30** | 6 | 0.67 | 9 | 31 | 1.499 | 0.604 | | 0 | 76 | | |
| 2 | **366** | **349** | 17 | 28.5 | **50** | 10 | 1.09 | 9 | 31 | 1.518 | 1.010 | | 0 | 216 | | |
| 3 | **349** | **344** | 5 | 39.5 | **56** | 11.2 | 1.44 | 8 | 31 | 1.396 | 1.224 | | 0 | 77 | | |
| 4 | **344** | **334** | 10 | 47 | **65** | 13 | 1.67 | 8 | 31 | 1.394 | 1.426 | | | 179 | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **334** | | 52 | **65** | 13 | 1.83 | 7 | 31.45 | | | 1 | 19 | | 237 | |
| | | | | | | | | | | | | | Totals: | 548 | 237 | 785 |

FS = 3.1

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 50 | | |
| $N_{corr}$: | 52 | | |
| $f_s$: | 0.503 tsf | $Q_s$: | 133 Tons |
| or (2) for Nonplastic Silt | **1** | $Q_p$: | 871 Tons |
| $q_p$: | 69 tsf | $Q_{ult}$: | 1004 Tons |
| | | FS = | 4.0 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 1** | Project Name | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$) = | **291.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation = | **376** ft | Date: | **8/2/2002** |
| Bottom of Caisson Elevatio | **331** ft | | |
| Diameter of Caisson (D) = | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface = | **386** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-4** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **7.0** ft | | |
| Caisson Length = | **45.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **376** | **366** | 10 | 15 | **30** | 6 | 0.67 | 9 | 31 | 1.499 | 0.604 | | 0 | 76 | | |
| 2 | **366** | **349** | 17 | 28.5 | **50** | 10 | 1.09 | 9 | 31 | 1.518 | 1.010 | | 0 | 216 | | |
| 3 | **349** | **344** | 5 | 39.5 | **56** | 11.2 | 1.44 | 8 | 31 | 1.396 | 1.224 | | 0 | 77 | | |
| 4 | **344** | **334** | 10 | 47 | **65** | 13 | 1.67 | 8 | 31 | 1.394 | 1.426 | | | 179 | | |
| 5 | **334** | **331** | 3 | 53.5 | **70** | 14 | 1.88 | 7 | 31 | 1.365 | 1.567 | | | 59 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **331** | | 55 | **70** | 14 | 1.92 | 7 | 31.48 | | | 1 | 20 | | 254 | |
| | | | | | | | | | | | | | Totals: | 607 | 254 | 861 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 54 | | |
| $N_{corr}$: | 55 | | |
| $f_s$: | 0.542 tsf | $Q_s$: | 143 Tons |
| Enter (1) for Sand or (2) for | **1** | $Q_p$: | 919 Tons |
| $q_p$: | 73 tsf | $Q_{ult}$: | 1062 Tons |
| | | FS = | 3.6 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 1** | Project Name | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$) = | **300.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation = | **376** ft | Date: | **8/2/2002** |
| Bottom of Caisson Elevatio | **329** ft | | |
| Diameter of Caisson (D) = | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface = | **386** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-4** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **7.0** ft | | |
| Caisson Length = | **47.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-1F-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **376** | **366** | 10 | 15 | **30** | 6 | 0.67 | 9 | 31 | 1.499 | 0.604 | | 0 | 76 | | |
| 2 | **366** | **349** | 17 | 28.5 | **50** | 10 | 1.09 | 9 | 31 | 1.518 | 1.010 | | 0 | 216 | | |
| 3 | **349** | **344** | 5 | 39.5 | **56** | 11.2 | 1.44 | 8 | 31 | 1.396 | 1.224 | | 0 | 77 | | |
| 4 | **344** | **334** | 10 | 47 | **65** | 13 | 1.67 | 8 | 31 | 1.394 | 1.426 | | | 179 | | |
| 5 | **334** | **329** | 5 | 54.5 | **70** | 14 | 1.91 | 7 | 31 | 1.353 | 1.580 | | | 99 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **329** | | 57 | **70** | 14 | 1.99 | 7 | 31.48 | | | 1 | 20 | | 255 | |
| | | | | | | | | | | | | | Totals: | 647 | 255 | 902 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 54 | | |
| $N_{corr}$: | 54 | | |
| $f_s$: | 0.542 tsf | $Q_s$: | 143 Tons |
| Enter (1) for Sand or (2) for | **1** | $Q_p$: | 906 Tons |
| $q_p$: | 72 tsf | $Q_{ult}$: | 1049 Tons |
| | | FS = | 3.5 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 2** | Project Name | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$) = | **250.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation = | **363.5** ft | Date: | **8/1/2002** |
| Bottom of Caisson Elevatio | **313.5** ft | | |
| Diameter of Caisson (D) = | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface = | **370.7** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-3** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **7.0** ft | | |
| Caisson Length = | **50.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-1F-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **363.5** | **348.5** | 15 | 14.7 | **0** | 2E-08 | 0.66 | 0 | 0 | 0.968 | 0.001 | | 0 | 0 | | |
| 2 | **348.5** | **339** | 9.5 | 26.95 | **30** | 6 | 1.04 | 6 | 31 | 1.193 | 0.749 | | 0 | 89 | | |
| 3 | **339** | **313.5** | 25.5 | 44.45 | **60** | 12 | 1.59 | 8 | 31 | 1.372 | 1.334 | | 0 | 428 | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **313.5** | | 57.2 | **60** | 12 | 1.99 | 6 | 31.42 | | | 1 | 18 | | 226 | |
| | | | | | | | | | | | | | Totals: | 517 | 226 | 743 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 30 | | |
| $N_{corr}$: | 46 | | |
| $f_s$: | 0.300 tsf | $Q_s$: | 79 Tons |
| or (2) for Nonplastic Silt | 1 | $Q_p$: | 776 Tons |
| | | $Q_{ult}$: | 855 Tons |
| $q_p$: | 62 tsf | | |
| | | FS = | 3.4 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 2** | Project Name | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$) = | **271.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation = | **363.5** ft | Date: | **8/1/2002** |
| Bottom of Caisson Elevatio | **310.5** ft | | |
| Diameter of Caisson (D) = | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface = | **370.7** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-3** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **7.0** ft | | |
| Caisson Length = | **53.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **363.5** | **348.5** | 15 | 14.7 | **0** | 2E-08 | 0.66 | 0 | 0 | 0.968 | 0.001 | | 0 | 0 | | |
| 2 | **348.5** | **339** | 9.5 | 26.95 | **30** | 6 | 1.04 | 6 | 31 | 1.193 | 0.749 | | 0 | 89 | | |
| 3 | **339** | **310.5** | 28.5 | 45.95 | **60** | 12 | 1.64 | 7 | 31 | 1.351 | 1.353 | | 0 | 485 | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **310.5** | | 60.2 | **60** | 12 | 2.09 | 6 | 31.42 | | | 1 | 18 | | 228 | |
| | | | | | | | | | | | | | Totals: | 574 | 228 | 802 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 30 | | |
| $N_{corr}$: | 45 | | |
| $f_s$: | 0.300 tsf | $Q_s$: | 79 Tons |
| or (2) for Nonplastic Silt | **1** | $Q_p$: | 760 Tons |
| | | $Q_{ult}$: | 839 Tons |
| $q_p$: | 60 tsf | | |
| | | FS = | 3.1 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 2** | Project Name | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$) = | **300.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation = | **363.5** ft | Date: | **8/1/2002** |
| Bottom of Caisson Elevatio | **305.5** ft | | |
| Diameter of Caisson (D) = | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface = | **370.7** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-3** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **7.0** ft | | |
| Caisson Length = | **58.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **363.5** | **348.5** | 15 | 14.7 | **0** | 2E-08 | 0.66 | 0 | 0 | 0.968 | 0.001 | | 0 | 0 | | |
| 2 | **348.5** | **339** | 9.5 | 26.95 | **30** | 6 | 1.04 | 6 | 31 | 1.193 | 0.749 | | 0 | 89 | | |
| 3 | **339** | **305.5** | 33.5 | 48.45 | **60** | 12 | 1.72 | 7 | 31 | 1.319 | 1.383 | | 0 | 582 | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **305.5** | | 65.2 | **60** | 12 | 2.24 | 5 | 31.42 | | | 1 | 18 | | 231 | |
| | | | | | | | | | | | | | Totals: | 672 | 231 | 903 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 30 | | |
| $N_{corr}$: | 44 | | |
| $f_s$: | 0.300 tsf | $Q_s$: | 79 Tons |
| Enter (1) for Sand or (2) for | **1** | $Q_p$: | 736 Tons |
| $q_p$: | 59 tsf | $Q_{ult}$: | 815 Tons |
| | | FS = | 2.7 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 3** | Project Name: | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$): | **258.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation: | **362** ft | Date: | **7/31/2002** |
| Bottom of Caisson Elevation | **312** ft | | |
| Diameter of Caisson (D): | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface: | **368.8** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-2** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **5.0** ft | | |
| Caisson Length = | **50.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **360** | **357** | 3 | 10.3 | **0** | 2E-06 | 0.47 | 0 | 0 | 0.892 | 0.004 | | 0 | 0 | | |
| 2 | **357** | **349** | 8 | 15.8 | **15** | 3 | 0.64 | 5 | 30 | 1.082 | 0.403 | | 0 | 41 | | |
| 3 | **349** | **331.7** | 17.3 | 28.45 | **40** | 8 | 1.03 | 8 | 31 | 1.391 | 0.871 | | 0 | 189 | | |
| 4 | **331.7** | **312** | 19.7 | 46.95 | **60** | 12 | 1.61 | 7 | 31 | 1.363 | 1.343 | | 0 | 332 | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **312** | | 56.8 | **60** | 12 | 1.92 | 6 | 31.42 | | | 1 | 18 | | 224 | |
| | | | | | | | | | | | | | Totals: | 562 | 224 | 787 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 29 | | |
| $N_{corr}$: | 47 | | |
| $f_s$: | 0.288 tsf | $Q_s$: | 76 Tons |
| Enter (1) for Sand or (2) for Nonplastic Silt | **1** | $Q_p$: | 788 Tons |
| | | $Q_{ult}$: | 863 Tons |
| $q_p$: | 63 tsf | | |
| | | FS = | 3.3 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 3** | Project Name: | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$): | **277.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation: | **362** ft | Date: | **7/31/2002** |
| Bottom of Caisson Elevation | **309** ft | | |
| Diameter of Caisson (D): | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface: | **368.8** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-2** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **5.0** ft | | |
| Caisson Length = | **53.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **360** | **357** | 3 | 10.3 | **0** | 2E-06 | 0.47 | 0 | 0 | 0.892 | 0.004 | | 0 | 0 | | |
| 2 | **357** | **349** | 8 | 15.8 | **15** | 3 | 0.64 | 5 | 30 | 1.082 | 0.403 | | 0 | 41 | | |
| 3 | **349** | **331.7** | 17.3 | 28.45 | **40** | 8 | 1.03 | 8 | 31 | 1.391 | 0.871 | | 0 | 189 | | |
| 4 | **331.7** | **309** | 22.7 | 48.45 | **60** | 12 | 1.66 | 7 | 31 | 1.342 | 1.361 | | 0 | 388 | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **309** | | 59.8 | **60** | 12 | 2.02 | 6 | 31.42 | | | 1 | 18 | | 226 | |
| | | | | | | | | | | | | | Totals: | 618 | 226 | 845 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 29 | | |
| $N_{corr}$: | 46 | | |
| $f_s$: | 0.288 tsf | $Q_s$: | 76 Tons |
| Enter (1) for Sand or (2) for Nonplastic Silt | **1** | $Q_p$: | 772 Tons |
| $q_p$: | 61 tsf | $Q_{ult}$: | 847 Tons |
| | | FS = | 3.1 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 3** | Project Name: | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$): | **300.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation: | **362** ft | Date: | **7/31/2002** |
| Bottom of Caisson Elevation | **306** ft | | |
| Diameter of Caisson (D): | **4.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface: | **368.8** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-2** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **5.0** ft | | |
| Caisson Length = | **56.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **360** | **357** | 3 | 10.3 | **0** | 2E-06 | 0.47 | 0 | 0 | 0.892 | 0.004 | | 0 | 0 | | |
| 2 | **357** | **349** | 8 | 15.8 | **15** | 3 | 0.64 | 5 | 30 | 1.082 | 0.403 | | 0 | 41 | | |
| 3 | **349** | **331.7** | 17.3 | 28.45 | **40** | 8 | 1.03 | 8 | 31 | 1.391 | 0.871 | | 0 | 189 | | |
| 4 | **331.7** | **306** | 25.7 | 49.95 | **60** | 12 | 1.71 | 7 | 31 | 1.323 | 1.379 | | 0 | 445 | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **306** | | 62.8 | **60** | 12 | 2.11 | 6 | 31.42 | | | 1 | 18 | | 229 | |
| | | | | | | | | | | | | | Totals: | 676 | 229 | 904 |

FS = 3.0

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 29 | | |
| $N_{corr}$: | 45 | | |
| $f_s$: | 0.288 tsf | $Q_s$: | 76 Tons |
| Enter (1) for Sand | | $Q_p$: | 756 Tons |
| or (2) for | **1** | $Q_{ult}$: | 832 Tons |
| Nonplastic Silt | | | |
| $q_p$: | 60 tsf | FS = | 2.8 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutment 2 - Wingwalls**

Load ($Q_{applied}$) = **50.0** Tons

Top of Caisson Elevation = **400** ft

Bottom of Caisson Elevatio **360** ft

Diameter of Caisson (D) = **2.0** ft

Original Ground Surface = **406.5** ft

Closest Boring: **BB-1**

Depth to Water Table = **20.0** ft

Caisson Length = **40.0** ft

Project Name **Dill Branch Bridge - Latest Bridge Alignment**

Project No.: **PRA - SHIL 502(2)**

Date: **8/6/2002**

Moist Unit Weight of soil: **115** pcf

Saturated Unit Weight of soil: **120** pcf

Bouyant Unit Weight of soil: 57.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **400** | **395** | 5 | 9 | **0** | 2E-05 | 0.52 | 0 | 1 | 0.812 | 0.008 | | 0 | 0 | | |
| 2 | **395** | **383** | 12 | 17.5 | **9** | 1.8 | 1.01 | 2 | 29 | 0.678 | 0.384 | | 0 | 29 | | |
| 3 | **383** | **373** | 10 | 28.5 | **18** | 3.6 | 1.39 | 3 | 31 | 0.797 | 0.655 | | 0 | 41 | | |
| 4 | **373** | **363** | 10 | 370.4 | **13** | 2.6 | 11.24 | 0 | 30 | 0.240 | 1.560 | | 0 | 98 | | |
| 5 | **363** | **360** | 3 | 45 | **30** | 6 | 1.87 | 3 | 31 | 0.884 | 0.994 | | | 19 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **360** | | 46.5 | **30** | 6 | 1.91 | 3 | 31.01 | | | 1 | 10 | | 32 | |
| | | | | | | | | | | | | | Totals: | 187 | 32 | 219 |

FS = 4.4

**Meyerhof:**

$N_{ave}$: 14

$N_{corr}$: 24

$f_s$: 0.140 tsf

Enter (1) for Sand or (2) for: **1**

$q_p$: 31 tsf

$Q_s$: 18 Tons

$Q_p$: 99 Tons

$Q_{ult}$: 117 Tons

FS = 2.3

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutment 2 - Wingwalls**
Load ($Q_{applied}$) = **68.0** Tons
Top of Caisson Elevation = **400** ft
Bottom of Caisson Elevatio **355** ft
Diameter of Caisson (D) = **2.0** ft
Original Ground Surface = **406.5** ft
Closest Boring: **BB-1**
Depth to Water Table = **20.0** ft
Caisson Length = **45.0** ft

Project Name **Dill Branch Bridge - Latest Bridge Alignment**
Project No.: **PRA - SHIL 502(2)**
Date: **8/6/2002**

Moist Unit Weight of soil: **115** pcf
Saturated Unit Weight of soil: **120** pcf
Bouyant Unit Weight of soil: 57.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **400** | **395** | 5 | 9 | **0** | 2E-05 | 0.52 | 0 | 1 | 0.812 | 0.008 | | 0 | 0 | | |
| 2 | **395** | **383** | 12 | 17.5 | **9** | 1.8 | 1.01 | 2 | 29 | 0.678 | 0.384 | | 0 | 29 | | |
| 3 | **383** | **373** | 10 | 28.5 | **18** | 3.6 | 1.39 | 3 | 31 | 0.797 | 0.655 | | 0 | 41 | | |
| 4 | **373** | **363** | 10 | 370.4 | **13** | 2.6 | 11.24 | 0 | 30 | 0.240 | 1.560 | | 0 | 98 | | |
| 5 | **363** | **358** | 5 | 46 | **30** | 6 | 1.90 | 3 | 31 | 0.877 | 1.001 | | | 31 | | |
| 6 | **358** | **355** | 3 | 50 | **50** | 10 | 2.01 | 5 | 31 | 1.104 | 1.354 | | | 26 | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **355** | | 51.5 | **50** | 10 | 2.06 | 5 | 31.33 | | | 1 | 16 | | 49 | |
| | | | | | | | | | | | | | Totals: | 225 | 49 | 274 |

FS = 4.0

**Meyerhof:**

$N_{ave}$: 20
$N_{corr}$: 38
$f_s$: 0.200 tsf
Enter (1) for Sand or (2) for: **1**
$q_p$: 51 tsf

$Q_s$: 26 Tons
$Q_p$: 159 Tons
$Q_{ult}$: 186 Tons

FS = 2.7

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutment 2 - Wingwalls**

Load ($Q_{applied}$) = **75.0** Tons

Top of Caisson Elevation = **400** ft

Bottom of Caisson Elevatio **350** ft

Diameter of Caisson (D) = **2.0** ft

Original Ground Surface = **406.5** ft

Closest Boring: **BB-1**

Depth to Water Table = **20.0** ft

Caisson Length = **50.0** ft

Project Name **Dill Branch Bridge - Latest Bridge Alignment**

Project No.: **PRA - SHIL 502(2)**

Date: **8/6/2002**

Moist Unit Weight of soil: **115** pcf

Saturated Unit Weight of soil: **120** pcf

Bouyant Unit Weight of soil: 57.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **400** | **395** | 5 | 9 | **0** | 2E-05 | 0.52 | 0 | 1 | 0.812 | 0.008 | | 0 | 0 | | |
| 2 | **395** | **383** | 12 | 17.5 | **9** | 1.8 | 1.01 | 2 | 29 | 0.678 | 0.384 | | 0 | 29 | | |
| 3 | **383** | **373** | 10 | 28.5 | **18** | 3.6 | 1.39 | 3 | 31 | 0.797 | 0.655 | | 0 | 41 | | |
| 4 | **373** | **363** | 10 | 370.4 | **13** | 2.6 | 11.24 | 0 | 30 | 0.240 | 1.560 | | 0 | 98 | | |
| 5 | **363** | **358** | 5 | 46 | **30** | 6 | 1.90 | 3 | 31 | 0.877 | 1.001 | | | 31 | | |
| 6 | **358** | **350** | 8 | 52.5 | **50** | 10 | 2.09 | 5 | 31 | 1.084 | 1.377 | | | 69 | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **350** | | 56.5 | **50** | 10 | 2.20 | 5 | 31.33 | | | 1 | 16 | | 50 | |
| | | | | | | | | | | | | | Totals: | 269 | 50 | 319 |

FS = 4.3

**Meyerhof:**

$N_{ave}$: 20

$N_{corr}$: 37

$f_s$: 0.200 tsf

Enter (1) for Sand or (2) for: **1**

$q_p$: 49 tsf

$Q_s$: 26 Tons

$Q_p$: 155 Tons

$Q_{ult}$: 181 Tons

FS = 2.4

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 1** | Project Name | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$) = | **300.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation = | **376** ft | Date: | **8/12/2002** |
| Bottom of Caisson Elevatio | **311** ft | | |
| Diameter of Caisson (D) = | **3.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface = | **386** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-4** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **7.0** ft | | |
| Caisson Length = | **65.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-1F-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **376** | **366** | 10 | 15 | **30** | 6 | 0.67 | 9 | 31 | 1.499 | 0.604 | | 0 | 57 | | |
| 2 | **366** | **349** | 17 | 28.5 | **50** | 10 | 1.09 | 9 | 31 | 1.518 | 1.010 | | 0 | 162 | | |
| 3 | **349** | **344** | 5 | 39.5 | **56** | 11.2 | 1.44 | 8 | 31 | 1.396 | 1.224 | | 0 | 58 | | |
| 4 | **344** | **334** | 10 | 47 | **65** | 13 | 1.67 | 8 | 31 | 1.394 | 1.426 | | | 134 | | |
| 5 | **334** | **311** | 23 | 63.5 | **70** | 14 | 2.19 | 6 | 31 | 1.259 | 1.687 | | | 366 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **311** | | 75 | **70** | 14 | 2.55 | 5 | 31.48 | | | 1 | 21 | | 151 | |
| | | | | | | | | | | | | | Totals: | 777 | 151 | 928 |

FS = 3.1

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 54 | | |
| $N_{corr}$: | 48 | | |
| $f_s$: | 0.542 tsf | $Q_s$: | 107 Tons |
| Enter (1) for Sand or (2) for | **1** | $Q_p$: | 455 Tons |
| $q_p$: | 64 tsf | $Q_{ult}$: | 562 Tons |
| | | FS = | 1.9 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Pier 2**
Load ($Q_{applied}$) = **300.0** Tons
Top of Caisson Elevation = **363.5** ft
Bottom of Caisson Elevatio **293.5** ft
Diameter of Caisson (D) = **3.0** ft
Original Ground Surface = **370.7** ft
Closest Boring: **BB-3**
Depth to Water Table = **7.0** ft
Caisson Length = **70.0** ft

Project Name **Dill Branch Bridge - Latest Bridge Alignment**
Project No.: **PRA - SHIL 502(2)**
Date: **8/12/2002**

Moist Unit Weight of soil: **120** pcf
Saturated Unit Weight of soil: **125** pcf
Bouyant Unit Weight of soil: 62.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-1F-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **363.5** | **348.5** | 15 | 14.7 | **0** | 2E-08 | 0.66 | 0 | 0 | 0.968 | 0.001 | | 0 | 0 | | |
| 2 | **348.5** | **339** | 9.5 | 26.95 | **30** | 6 | 1.04 | 6 | 31 | 1.193 | 0.749 | | 0 | 67 | | |
| 3 | **339** | **305.5** | 33.5 | 48.45 | **60** | 12 | 1.72 | 7 | 31 | 1.319 | 1.383 | | 0 | 437 | | |
| 4 | **305.5** | **293.5** | 12 | 71.2 | **80** | 16 | 2.43 | 7 | 32 | 1.278 | 1.905 | | | 215 | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **293.5** | | 77.2 | **80** | 16 | 2.62 | 6 | 31.52 | | | 1 | 24 | | 169 | |
| | | | | | | | | | | | | | Totals: | 719 | 169 | 888 |

FS = 3.0

**Meyerhof:**

$N_{ave}$: 43
$N_{corr}$: 54
$f_s$: 0.425 tsf
Enter (1) for Sand or (2) for: **1**
$q_p$: 73 tsf

$Q_s$: 84 Tons
$Q_p$: 513 Tons
$Q_{ult}$: 597 Tons

FS = 2.0

# DRILLED SHAFT LOAD CAPACITY CALCULATION

| | | | |
|---|---|---|---|
| Column: | **Pier 3** | Project Name: | **Dill Branch Bridge - Latest Bridge Alignment** |
| Load ($Q_{applied}$): | **300.0** Tons | Project No.: | **PRA - SHIL 502(2)** |
| Top of Caisson Elevation: | **362** ft | Date: | **8/12/2002** |
| Bottom of Caisson Elevation | **292** ft | | |
| Diameter of Caisson (D): | **3.0** ft | Moist Unit Weight of soil: | **120** pcf |
| Original Ground Surface: | **368.8** ft | Saturated Unit Weight of soil: | **125** pcf |
| Closest Boring: | **BB-2** | Bouyant Unit Weight of soil: | 62.6 pcf |
| Depth to Water Table = | **5.0** ft | | |
| Caisson Length = | **70.0** ft | $P_a$ (Atmospheric Pressure): | 1 tsf |

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | ayer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $(S_u/\sigma_{vo}')$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **360** | **357** | 3 | 10.3 | **0** | 2E-06 | 0.47 | 0 | 0 | 0.892 | 0.004 | | 0 | 0 | | |
| 2 | **357** | **349** | 8 | 15.8 | **15** | 3 | 0.64 | 5 | 30 | 1.082 | 0.403 | | 0 | 30 | | |
| 3 | **349** | **331.7** | 17.3 | 28.45 | **40** | 8 | 1.03 | 8 | 31 | 1.391 | 0.871 | | 0 | 142 | | |
| 4 | **331.7** | **306** | 25.7 | 49.95 | **60** | 12 | 1.71 | 7 | 31 | 1.323 | 1.379 | | 0 | 334 | | |
| 5 | **306** | **292** | 14 | 69.8 | **80** | 16 | 2.33 | 7 | 32 | 1.307 | 1.866 | | | 246 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **292** | | 76.8 | **80** | 16 | 2.55 | 6 | 31.52 | | | 1 | 24 | | 168 | |
| | | | | | | | | | | | | | Totals: | 753 | 168 | 921 |

FS = 3.1

**Meyerhof:**

| | | | |
|---|---|---|---|
| $N_{ave}$: | 39 | | |
| $N_{corr}$: | 55 | | |
| $f_s$: | 0.390 tsf | $Q_s$: | 77 Tons |
| Enter (1) for Sand or (2) for Nonplastic Silt | **1** | $Q_p$: | 520 Tons |
| $q_p$: | 74 tsf | $Q_{ult}$: | 597 Tons |
| | | FS = | 2.0 |

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutments 1 & 2**
Load ($Q_{applied}$): **82** Tons
Top of Caisson Elevatión: **407** ft
Bottom of Caisson Elevatio **362** ft
Diameter of Caisson (D): **2** ft
Original Ground Surface: **415** ft
Closest Boring: **B-2**
Depth to Water Table: **4** ft
Caisson Length = **45.0** ft

Project Name **Tilghman Bridge**
Project No.: **PRA - SHIL 502(2)**
Date: **7/22/2002**

Moist Unit Weight of soil: **120** pcf
Saturated Unit Weight of soil: **125** pcf
Bouyant Unit Weight of soil: 62.6 pcf

$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | Layer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $S_u/\sigma_{vo}'$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **407** | **394** | 13.1 | 14.7 | **0** | 0 | 0.57 | 0 | 1 | 0.810 | 0.009 | | 0 | 1 | | |
| 2 | **394** | **388** | 5.27 | 23.9 | **12** | 2.4 | 0.86 | 3 | 30 | 0.835 | 0.414 | | 0 | 14 | | |
| 3 | **388** | **377** | 11.1 | 32.1 | **21** | 4.2 | 1.12 | 4 | 31 | 0.962 | 0.639 | | 0 | 45 | | |
| 4 | **377** | **372** | 4.94 | 40.1 | **43** | 8.6 | 1.37 | 6 | 31 | 1.248 | 1.038 | | 0 | 32 | | |
| 5 | **372** | **362** | 10.6 | 47.8 | **65** | 13 | 1.61 | 8 | 31 | 1.421 | 1.401 | | | 93 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below** | **362** | | 53.1 | **65** | 13 | 1.78 | 7 | 31.4 | | | 1 | 19 | | 59 | |
| | | | | | | | | | | | | | Totals: | 184 | 59 | 243 |

FS = 3.0

**Meyerhof:**

$N_{ave}$: 28
$N_{corr}$: 53
$f_s$: 0.282 tsf
Enter (1) for Sand or (2) for Nonplastic Silt: **1**
$q_p$: 70 tsf

$Q_s$: 37 Tons
$Q_p$: 220 Tons
$Q_{ult}$: 258 Tons
FS = 3.1

# DRILLED SHAFT LOAD CAPACITY CALCULATION

Column: **Abutments 1 & 2**
Load ($Q_{applied}$): **105** Tons
Top of Caisson Elevation: **406.7** ft
Bottom of Caisson Elevatio **361.7** ft
Diameter of Caisson (D): **2.5** ft
Original Ground Surface: **414.8** ft
Closest Boring: **B-2**
Depth to Water Table: **4** ft
Caisson Length = **45.0** ft

Project Name **Tilghman Bridge**
Project No.: **PRA - SHIL 502(2)**
Date: **7/22/2002**

Moist Unit Weight of soil: **120** pcf
Saturated Unit Weight of soil: **125** pcf
Bouyant Unit Weight of soil: 62.6 pcf
$P_a$ (Atmospheric Pressure): 1 tsf

**FHWA (Ref. No. 41-30-2175 & Publication No. FHWA A-IF-99-025):**

| Layer | Layer Elev. (ft) | | T | Depth | $N_{60}$ | $\sigma_p'$ | $\sigma_{vo}'$ | OCR | $\phi'$ | $K_o$ | $f_s$ | $S_u/\sigma_{vo}'$ | $q_{ult}$ | $Q_s$ | $Q_p$ | $Q_{ult}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | from | to | (ft) | (ft) | | (tsf) | (tsf) | | | | (tsf) | | (tsf) | (Tons) | (Tons) | (Tons) |
| 1 | **406.7** | **393.6** | 13.1 | 14.67 | **0** | 0 | 0.57 | 0 | 1 | 0.810 | 0.009 | | 0 | 1 | | |
| 2 | **393.6** | **388.3** | 5.27 | 23.86 | **12** | 2.4 | 0.86 | 3 | 30 | 0.835 | 0.414 | | 0 | 17 | | |
| 3 | **388.3** | **377.2** | 11.1 | 32.07 | **21** | 4.2 | 1.12 | 4 | 31 | 0.962 | 0.639 | | 0 | 56 | | |
| 4 | **377.2** | **372.3** | 4.94 | 40.09 | **43** | 8.6 | 1.37 | 6 | 31 | 1.248 | 1.038 | | 0 | 40 | | |
| 5 | **372.3** | **361.7** | 10.6 | 47.82 | **65** | 13 | 1.61 | 8 | 31 | 1.421 | 1.401 | | | 117 | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| | **below 361.7** | | | 53.12 | **65** | 13 | 1.78 | 7 | 31.45 | | | 1 | 19 | | 92 | |
| | | | | | | | | | | | | | Totals: | 231 | 92 | 323 |

FS = 3.1

**Meyerhof:**

$N_{ave}$: 28
$N_{corr}$: 53
$f_s$: 0.282 tsf
Enter (1) for Sand or (2) for Nonplastic Silt: **1**
$q_p$: 70 tsf

$Q_s$: 47 Tons
$Q_p$: 344 Tons
$Q_{ult}$: 391 Tons
FS = 3.7